

Application Number 10/626,212
Amendment dated 11 February 2005
Reply to Office Action of 19 November 2004

Remarks

Claims 3, 7, 13 and 16 have been cancelled, and no new claims have been added. Therefore, Claims 2, 4–6, 8–10, 12, 14, 15, and 17–19 are pending in this application. Claims 6, 9, 10, 18 and 19 are independent. Claims 2, 4, 5 and 8 depend from independent Claim 6. Claims 12, 14, 15 and 17 depend from independent Claim 19.

Claim Rejections Under 35 U.S.C. § 102

Claims 2–5, 7–10 and 12–19 were rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent 6,551,399 ("Sneh '399"). Claims 3, 7, 13 and 16 have been cancelled. Claims 2, 4, 5 and 8 now depend from Claim 6.

Sneh '399 discloses methods for forming metal-insulator-metal capacitors using atomic layer deposition processes (1:11–14). This process is reproduced in Figures 8–10 of Sneh '399, which are reproduced below for the Examiner's convenience. In this process, an Al₂O₃ dielectric layer 14 is pretreated using an NH₃/H₂/N₂ plasma to provide ample surface terminations 19 (6:46–55). Then, a second metallization layer 15, which comprises W or W_xN, is deposited over the activated surface of the dielectric layer 14 using an atomic layer deposition technique (6:55–61).

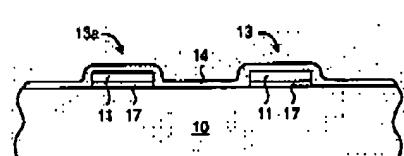


FIG. 8

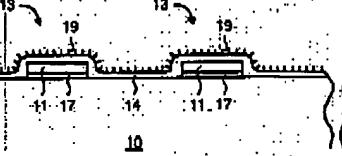


FIG. 9

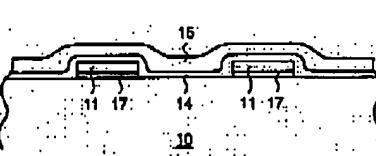


FIG. 10

Claim 9. In contrast to the methods disclosed in Sneh '399, Applicants have amended Claim 9 to recite:

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Claim 9 (currently amended): A method of depositing a film on a semiconductor surface in a partially fabricated integrated circuit, the method comprising:

exposing the surface to products of a plasma, thereby modifying termination of the semiconductor surface without significantly affecting bulk properties beneath the surface; and

after modifying the surface termination, depositing a layer thereover using an atomic layer deposition process;

wherein the atomic layer deposition process comprises a metal oxide deposition. [emphasis added]

Sneh '399 does not teach these limitations. As described above, Sneh '399 teaches methods for deposition of a metallization film on a dielectric layer. Sneh '399 contains no disclosure of methods for "modifying termination of [a] semiconductor surface," as is recited in amended Claim 9. Therefore, Applicants submit that Sneh '399 does not anticipate amended Claim 9, and suggest that amended Claim 9 is allowable over Sneh '399, and respectfully request that this rejection be withdrawn.

Claim 10. In contrast to the methods disclosed in Sneh '399, Applicants have amended Claim 10 to recite:

Claim 10 (currently amended): A method of depositing a film on a semiconductor surface in a partially fabricated integrated circuit, the method comprising:

exposing the surface to products of a plasma, thereby modifying termination of the semiconductor surface without significantly affecting bulk properties beneath the surface; and

after modifying the surface termination, depositing a layer thereover using an atomic layer deposition process;

wherein the atomic layer deposition process comprises two reactant pulses with intervening purge pulses in each cycle. [emphasis added]

Sneh '399 does not teach these limitations. As described above, Sneh '399 teaches methods for deposition of a metallization film on a dielectric layer. Sneh '399 contains no disclosure of methods for "modifying termination of [a] semiconductor surface," as is recited in amended Claim 10. Therefore, Applicants submit that Sneh '399 does not anticipate amended Claim 10, and suggest that amended Claim 10 is allowable over Sneh '399, and respectfully request that this rejection be withdrawn.

Claim 18. In contrast to the methods disclosed in Sneh '399, Applicants have amended Claim 18 to recite:

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Claim 18 (currently amended): A method of depositing a film on a **semiconductor surface** in a partially fabricated integrated circuit, the method comprising:
exposing the surface to products of a plasma, thereby **modifying termination of the semiconductor surface** without depositing greater than one atomic monolayer of the products of the plasma on the surface; and
after modifying the surface termination, depositing a layer thereover using an atomic layer deposition process;
wherein the atomic layer deposition process comprises a metal oxide deposition. [emphasis added]

Sneh '399 does not teach these limitations. As described above, Sneh '399 teaches methods for deposition of a metallization film on a **dielectric layer**. Sneh '399 contains no disclosure of methods for "modifying termination of [a] semiconductor surface," as is recited in amended Claim 18. Therefore, Applicants submit that Sneh '399 does not anticipate amended Claim 18, and suggest that amended Claim 18 is allowable over Sneh '399, and respectfully request that this rejection be withdrawn.

Claims 12, 14, 15, 17 and 19. In contrast to the methods disclosed in Sneh '399, Applicants have amended Claim 19 to recite:

Claim 19 (currently amended): A method of depositing a film on a **semiconductor surface** in a partially fabricated integrated circuit, the method comprising:
exposing the surface to products of a plasma, thereby **modifying termination of the semiconductor surface** without depositing greater than one atomic monolayer of the products of the plasma on the surface; and
after modifying the surface termination, depositing a layer thereover using an atomic layer deposition process;
wherein the atomic layer deposition process comprises two reactant pulses with intervening purge pulses in each cycle. [emphasis added]

Sneh '399 does not teach these limitations. As described above, Sneh '399 teaches methods for deposition of a metallization film on a **dielectric layer**. Sneh '399 contains no disclosure of methods for "depositing a film on a semiconductor surface," as is recited in amended Claim 19. Therefore, Applicants submit that Sneh '399 does not anticipate amended Claim 19, and suggest that amended Claim 19 is allowable over Sneh '399. Furthermore, because Claims 12, 14, 15 and 17 depend from Claim 19, Applicants submit that Claims 12, 14, 15 and 17 are allowable over Sneh '399 for the same reasons that Claim 19 is allowable over Sneh '399, in addition to reciting further

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distinguishing features of particular utility. Thus, Applicants respectfully request that these rejections be withdrawn.

Claim Rejections Under 35 U.S.C. § 103

Claim 6 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Sneh '399 in view of U.S. Patent 6,503,330 ("Sneh '330"). Claims 2, 4, 5, and 8 depend from independent Claim 6.

As cited by the Examiner, Sneh '330 discloses a method of atomic layer deposition of Al₂O₃ on a silicon substrate. The silicon substrate is first activated by exposing an HF-cleaned silicon surface to a pulse of H₂O at a temperature below 430°C, thereby resulting in a self-saturated layer of SiO₂ that is approximately 5 angstroms thick. Therefore, Sneh '330 teaches a non-plasma treatment to facilitate Al₂O₃ nucleation.

Claim 6. In contrast to the methods disclosed in Sneh '399 and Sneh '330, Applicants have amended Claim 6 to recite:

Claim 6 (currently amended): A method of depositing a film on a semiconductor surface in a partially fabricated integrated circuit, the method comprising:

exposing the surface to products of a plasma, thereby modifying termination of the semiconductor surface without significantly affecting bulk properties beneath the surface; and

after modifying the surface termination, depositing a layer thereover using an atomic layer deposition process;

wherein exposing incorporates less than 10 atomic % of the products of the plasma at a depth of greater than about 10 Å from the surface.

Neither Sneh '399 nor Sneh '330 teaches these limitations. As described above, Sneh '399 teaches methods for deposition of a metallization film on a dielectric layer. Sneh '399 contains no disclosure of methods for "depositing a film on a semiconductor surface." While Sneh '330 does teach a method for deposition of Al₂O₃ on a silicon substrate, there is no indication that this method is a plasma treatment method. Rather, Sneh '330 discloses a non-plasma treatment of the silicon substrate to facilitate Al₂O₃ nucleation. Nor does Sneh '399 provide any reason to think that its plasma treatment would be beneficial to treating semiconductor surfaces at all, much less that it would be superior to Sneh '330's disclosed non-plasma treatment of semiconductor surfaces.

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The Examiner has identified no motivation for the ordinarily-skilled artisan to combine the non-plasma methods disclosed in Sneh '330 with the plasma treatment methods disclosed in Sneh '399.

A *prima facie* case of obviousness requires some suggestion or motivation, either in the references themselves or in the knowledge generally available to an ordinarily-skilled artisan, to modify a reference or to combine reference teachings. As noted during prosecution of the parent application, now U.S. Patent 6,613,695, teachings of non-plasma treatment cannot be equated with plasma treatment without specific suggestions from the prior art. Likewise, in this case, Applicants respectfully submit that there is no suggestion in the references themselves or in the knowledge generally available to an ordinarily-skilled artisan to combine a reference teaching a non-plasma treatment of a semiconductor surface with a reference teaching plasma treatment of a dielectric surface.

Therefore, Applicants respectfully submit that amended Claim 6 is allowable over Sneh '399 and Sneh '330. Furthermore, because Claims 2, 4, 5 and 8 depend from Claim 6, Applicants submit that Claims 2, 4, 5 and 8 are allowable over Sneh '399 and Sneh '330 for at least the same reasons that Claim 6 is allowable over Sneh '399 and Sneh '330, in addition to reciting further distinguishing features of particular utility. Thus, Applicants respectfully request that these rejections be withdrawn.

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Conclusion

In view of the foregoing amendments, the Applicants submit that this application is in condition for allowance, and respectfully request the same. If, however, some issue remains that the Examiner feels can be addressed by an Examiner's Amendment, the Examiner is cordially invited to call the undersigned for authorization.

Respectfully submitted,

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Dated: 11 feb 05

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